Ministry of Public Building and Works
Directorate of Research and Information

Coding and Data Co-ordination: A Short Report

Prepared by the Committee on the Application of Computers in the Construction Industry

London: Her Majesty's Stationery Office: 1969

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Foreword

by the Minister of Public Building and Works

The Increasing use of computers by ell sections of the construction industry hes highlighted the problem of communicetion. My Committee on the Applicetion of Computers in the Construction Industry recognised the need for an eerly study of the communication problems essocieted with the flow of data and information. This report contains the findings of e Sub-Committee end Study Teem who cerried out en investigetion and mede e number of recommendations. The Teem heve not produced e system as such, but e performence specificetion for e system.

In view of the importance of this work, end the need to obtain early consideration by the Industry of the report, I have arranged for e Working Group of the National Consultative Council, the industry's representetive body, to be formed to edvise me on the meesures necessary to implement the proposels embodied in the report.

I hope that everyone in the industry will read this report end be prepared to assist in the implementation of its proposals. Better communicetions will bring benefits to all sectors of the industry and to the country at lerge.

R. J. Mellish
November 1968

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1 Introduction

The Committee on the Application of Computers in the Construction Industry was appointed by the Minister of Public Building end Works in 1966 to review computer applications in the industry, essese the need for co-ordinating effort and promota further advance. At the outset, it became clear that such progress as had been made, some of it considerable, had been almost wholly confined to individual and separate processes. Structural design, bills of quantities end suppliers' stock control were prominent examples. Eech of these applications had been developed for use in a particular sector with little regard for the needs of other sectors.

The Committee's brief required that it should look et ways of making the best use of computers in the service of the construction industry. This separation into self contained processes was seen as a fundamental obstacle to the increased use of computers.

Computers are tools that can handle great amounts of deta with speed, flexibility and accuracy but they must be supplied with more precise data than manual systems require. To avoid unnecessary duplication of work it is also desirable that computer systems devised for construction industry applications be so constructed that data, once input to the computer, is subsequently available in an appropriate form for use, not only by the first user but by all other users that require this information at any stage of design end construction.

If computers ere to be used to best advantage the present conglomeration of specialised vocabularies must be replaced by a rationalised system of communicetion which ia common to all sectors of the industry and can be used right across professional boundaries.

To eseist the Committee in its investigetion of this problem a Study Team was formed at the Building Reseerch Station. Its terms of reference were "to study the present characteristics and probable davelopment of the information used in the design and execution of construction work; to determine the criteria for a coding system that would enable computer-processed information to be used more effectively, both within individual firms and offices end in communications between them, thereby leading to greater efficiency end economy; and to make recommendations".

The Study Teem wes made up of staff of the Building Research Station supplemented by steff from the headquarters of the Ministry of Public Building and Works and from the Heating and Ventileting Research Associetion. Additional help was provided by eight firms of consultants and many individuals and firms from the industry.

A Sub-Committee was appointed under the chairmanship of Mr. Alex Gordon OBE, DipArch FRIBA, with the following terms of reference; "To guide the work of the team esteblished jointly by the Building Reseerch Station end the Ministry of Public Building and Works to undertake the study of coding and data co-ordinetion es defined by the Committee; to receive and consider the report of the team; and to submit e report to the Committee with recommendetions on the ection which might subsequently be teken".

The Sub-Committee's members, though serving in their personal capacities, had links with the institutions and other orgenisations that were themselves concerned with the problem. During the course of the study the Sub-Committee had ten meetings with the representetives of the Study Team and edditional discussions were held between individuel members of the Sub-Committee and the Study Team.

The Report of the Study Team is seen as a major contribution to greeter understanding of the wey in which the construction industry works. This paper, which hes been prepared by the Sub-Committee is besed upon the Report of the Study Team*. It describes the present situetion and the way the study was carried out before summarising the main findings and recommendations. The final section gives deteiled proposals for implementing the recommendetions.

Members of the Mein end Sub-Committee and the Study Team ere listed in Appendices A–C.

*BISHOP, D. and ALSOP, K. A Study of Coding and Data Co-ordination for the Construction Industry, London, 1969, HMSO 20s.

2 The present position

It takes but two words to express the "construction industry", but their meaning is veriable and complex. This industry includes a range of sectors, from tha designers who grapple with the client's naads to the manufacturers who produce the materials, and tha contractors and sub-contractors who execute the construction. The parties to the building process come in all shapes and sizes, and at varying levels of operational organisation, to perform the total task demanded of them. All have their function and, in their differant ways, all fulfil it.

Tha design and construction process itself is a thing of fits and starts. It begins when the client talks to the designer and it proceeds through e sequence of operations to the completion of the project. Each of these operations has its own methods of collecting information, processing it, applying it and transmitting the resultant products to its neighbours in the sequence. Time and money have to be expended at each stage to translate the information that has baen produced and re-generate it in new terms in order to negotiate the next stage. Effort is being devoted to a restatement that does not in itself advance the project. It means, quite simply, that construction costs more than it should because of the shortcomings of its communication systems.

It would be a rash man who ventured to pradict how the industry should be organised to meet these short-comings. But it is not difficult to deduce that communications must be improved if a more efficient and economically-organised industry is to develop.

For some time now, many paople in the industry have been awara of the need to devise a mathod whereby the information for a project could be established in a concise and meaningful form, so that it can be drawn on readily by whoever needs it at whatever stage without the intervention of complicated processes of translation.

Clearly there are great advantages to be derived from such a method. To take simple examples, the existence of a comprehensive statement of building materials and products would enable everyone engaged in the construction sequence to draw on a total store-house of the industry's knowledge instead of the "know how" that happens to lie within his own or his neighbour's ken. A common language would improve communications batween all parties; feed-back from manufacturer and contractor to designer could be facilitated and much abortive work avoided. A closer integration of the design team would become possible, with all the benefits that flow from it. And the bill of quantities could give way to a feed-out of the right amount of information, required by the right people at the right times.

This concept is not new. Over thirty systems have been developed by architects, quantity surveyors, engineers, merchants, manufacturers and contractors that are designed to rationalise information. But the efforts so far made, like the procadures they supplant, are limited in application. No system so far developed satisfies the whole of the construction industry over the whole of its saquence of activities. The further unco-ordinated development of systems, though beneficial within a limited context, could delay progress towards an egreed system by producing a modern version of the restricted and compartmental system of which we want to be free. Development of partial systems, though valuable in the short term, is no ultimata solution. For that we must look to an analysis that will lay bare both the total process and the total language needed to satisfy the process.

The BRS. Study is probably the most exhaustive analysis of the construction process that has been undertaken. It provides criteria against which those systems already developed can be judged and lays down guidelines for the development of new compatible systems.

Account has been taken of the veluable experience gained from existing systems end also of the work being carried out by other organisations into the problems of coding and data co-ordination.

3 The Study

The Study Team started work in January, 1967 and soon found that the characteristics of the construction industry bedevilled their first attempts to analyse the construction process. It had been thought thet the best approech would be to carry out cese studies of a number of construction projects. But it soon became apparent that this technique wes inadequate.

A number of alternative courses were considered before the Team decided to base their work on a model of the building process. This model was based on the assumption that the whole building process can be divided into a number of separate tasks or functions each of which achieves a recognisable goal. Having defined the functions the team divided eech function into smaller units, which they termed procedures, eech of which consisted of one or more operations. At this point the deta used for each operation could be identified.

By developing a number of procedures the team hoped that it would be able to study in detail parts of the construction process. If it could be shown thet these parts were typical the Teem believed thet their work would be applicable to the construction process as a whole.

The procedures that the Team developed were tested in two ways. First they were discussed with a large number of practitioners in the industry to test whether they were reelistic end thus to discover whether or not the model wes e satisfectory basis for study. Secondly they were used in a simuleted design exercise in which the teem looked et the links between the participants and the procedures to determine, in conjunction with field triels, the items of information that were common to a number of procedures end were exchenged between several functions.

Both the field tests end the design exercise velideted the Team's approach and showed thet the procedures, modified where neoessary as the result of the field tests, were practicable end represented the ordinery day-to-day work of the industry.

The Team were then eble to move to more deteiled study of each procedure and eventually to formulate recommendations that, elthough besed on selected perts, would be relevent to the whole construction process.

4 The Report

The Report of the Study Team* gives the framework for a co-ordinated information system that would provide all participants in the construction process with a atandard means of communication. The criteria for such a system and the recommendations for its main elements are given in Sections 5 and 6 of this report.

Three main areas were considered by the Study Team in formulating the criteria and recommendations: the rôle of information in the industry, data co-ordination and coding. Each of these areas is now discussed.

1 Information

The general picture derived from the study is not one of lots of bits of informetion pessing between participants, but of a few basic types of information of interest to ell, and of e major need to consult previous experience (mostly data ebout projects) and other non-project information.

The first major type of information at the design stage is the statement of functional requirements on which the whole design rests. It defines the clients' requirements by stating the performance expected of the project, and the restraints on the freedom of designers—planning constraints, features important to the client, costs, timing. The limitations of many clients' briefs and the adventages that might flow from their improvement are well known but it is still necessery to take this espect into account in any study of information flow.

The second major type of information passing amongst participents is the form the building will take; shape, dimensions, sections, room sizes and so on. This information starts in a tentetive and imprecise form that is progressively made more precise throughout the design stage. Participants need to know the letest state of the information as the design proceeds; up-to-date information can prevent abortive work.

The third type of information is related to resources, especially humen resources, materiels, products and components. All participants need to identify and specify resources and to assure themselves that the performance of the resources selected matches the requirements.

Apart from these pieces of informetion participants meke considerable use of their own past experience and most are working within certain constraints such as regulations, standards and codes of practice. Benefits would accrue if the experience and records of all members of the project team could usefully be shered. A system for recording regulations, stendards, codea of practice could be related to building types, functionel systems and building elements so that this information might be presented in more immediate forms.

*A list of the chaptar heedings of the Report ie given in Appendix D.

2 Data co-ordination

Data co-ordination is a concise way of describing the rationalisation of the means and content of communications. Much of the study was taken up by attempts to discover and define the ways in which the industry communicetes. Field trials were included in the study and these showed the points at which some measure of rationalisation could be expected to produce beneficial results by leading to a better use of information already available, or to more economical working, or both.

The Report shows that great benefits can flow from data co-ordination by better arrangement of both the information required throughout the construction process and the media used to convey that informetion, such as drewings, specifications, bills of quantities, schedules, orders and instructions.

3 Coding

The third mein subject considered in the report is coding. Codes are systems of words, letters, numbers or other symbols designed to ensure economy, consistency and accurecy in the transmission and manipuletion of date.

The Report considers factors determining the length and structure of codes end identifies priorities for coding, before Indicating the type of code needed to meet the criterie.

Criteria and recommendations

From this examinetion of the functions of the building process were derived criteria and proposels for a framework for an information system that will serve the whole building process end allow the retrievel of data aa feedbeck about performance, price and costs. It must be stressed thet the Report does not give us such a system in detail. This is e considerable task that will entail the agreement of institutions and organisetions on many points of detail and one that will require many years of effort to eccomplish. The industry itself must provide all the bits and pieces thet will meke it up. But what the Report does is to show how each bit and each piece must be related if the totel system is to be of meximum use to all. It is, in e sense, a performance specification for e construction industry communications system.

5 The criteria

In steting the criteria the Report gives guidance on their use. When essessing en information system the most important first step is to establish what the system or code is intended to do. Those who develop systems should take as broad a view as they cen, bearing in mind that if they take too narrow a view of their purposes, the resulting system or code may have a very restricted future use.

So, first the rôles the system or code is designed to serve must be defined in the terms used in the criteria (e.g. "does this system or code classify information, or identify resources, or describe projects?"). The detailed criteria that are appropriate must then be worked through.

The criteria for the framework for an information system against which any system for coding and data co-ordination can be measured are its ability:

1 *To classify information* in sufficient categories for users' needs, and in particular to allow data to be retrieved in order:

to search through data about building types, functional systems, technical solutions, building elements, constructional methods, resources, commodities, materials, occupational groups, equipment

to select functional system, technical solution, arrangement, construction method and resources with regard to performance, specification, availability and cost

to check compliance with constraints and with regulations

to support feedback within and between projects.

2 *To identify end describa resources:*

to identify uniquely commodities (materials, products, and components embodied in construction, contractors' materials, consumable stores), equipment (plant and tools) end occupationel groups, in a way that will be convenient for the industry's transactions

to provide the means by which unique identifications cen be essigned to commodities etc. This should not involve long delays whilst identifiers are allocated and should be cheap to administer

to produce comprehensive central commodity, contractors' materials, consumable stores and equipment files. This would require appropriate clessification, agreed sets of properties for each commodity and resource, and e preferred vocabulary, and the means to achieve them.

3 *To describe projects* in terms of:

form, by co-ordinates or other methods

technical solutions, by describing work-pieces, identifying or specifying commodities comprising work-pieces, indicating the circumstances in which the work-piece will be completed, locating work-pieces within projects, and stating restraints to be observed

operational methods, by identifying the construction method, defining activities, specifying the resources to be employed, depicting the sequencing and timing of the resources, resource scheduling, and progress reports and costings.

4 *To foster the development of procedures:*

to provide categories necessary for data retrieval in ways to suit the needs of specialised procedures

to enable documents (drawings, schedules, specifications, bills of quantities, programmes, project proposals, resource schedules), to be arranged in ways convenient to users

to provide the means of co-ordinating conventions evolved for specialist procedures or groups of procedures, a task that includes the development, revision and extension of a preferred vocabulary

to provide the means to prepare suites of related procedures.

5 *To support information flow:*

to identify, for various users, the ways in which information should be structured in order to meet their requirements and to avoid interpretation into another form

to establish a structuring for the documents used in the industry

to identify the categories of information relevant to each document

to provide systems cross-referencing between documents

to establish a framework for accepting, identifying and categorizing standard details, and specification preliminary and preamble clauses

to provide the means of co-ordinating such standardisation

to provide the means of making methods that allow the multiple use of data known and adopted.

Practical considerations

A system must be capable of implementation in stages.

A system must be hospitable to separate, but related, sub-systems.

A system must include the means to co-ordinate its development.

A system must involve and be acceptable to the industry because implementation will affect the whole industry.

Commercial considerations

A system should not cloud the responsibilities of participants.

A system must preserve commercial and professional security.

Human factors

Implementation of systems should include prior consultation with those directly involved.

The characteristics of a system should be acceptable to users and adapted to suit their experience and interests.

Implementation of all or part of the system must be supported by edequete training.

Vehicles for conveying information should be adequate in content, clear, reliebie and economical.

Codes for documents

Input documents

Accurate production and checking of codes should be easy. This implies thet encoding procedures should be appropriate to the skills of the persons involved and thet time for referring to code keys should be minimised.

They should be short for economy of input document production (writing, punching etc) and computer input time.

Symbols appropriate to computer in put devices should be used.

Computer time for input codes to be translated into on-file document codes should not be excessive.

On-file documents

Codes should be short for economy of storage and internel computer transfer time.

They should be suiteble for the types of file processing required such es retrieval, sorting, producing output in order to minimise processing times.

Output documents

Codes should be easy to interpret by the user and therefore eppropriete to his skills.

They should be appropriate to the computer output facilities.

6 Recommendations

Section 4 described the examination of the functions of the building process carried out by the Study Team. From this a framework for a co-ordinated information system has been proposed, the main elements of this being :

1 A prefarred vocabulary
2 Classification categories
3 Conventions
4 Central commodity files
5 Procedures
6 Codes

1 *A preferred vocabulary*
This would be composed of the descriptors used in the other components of the framework. A start could be made by including the words used in the classification categories and in conventions, together with words describing work-piaces (drawn from libraries for bills of quantities) because these are in general usage. The vocabulary could be extended to include descriptors required for the plain language element of commodity identifiers, although many could be drawn from libraries for bills of quantities. In the course of time it may prove necessary to expand the vocabulery to include words used in proceduras.

2 *Classification categories*
Tha development of classificetion categorias would allow information to be filed, retrieved and sorted in ways useful to the industry. The Report discusses this at length and suggests a besis for the development of suitable categories including building type, functional system, construction method, work sectors and the like.

3 *Convantions*
Conventions are codification of practice for convenience and to provide the precision essential to better communications. The industry already uses many conventions. The Report recommends the development of conventions of three kinds ; for feedback end performanca data ; for procedures, and for production information.

4 *Commodity file*
Great amphasis is placed on the need for a commodity file in which information about materials, products, end components would be stored and made available to users throughout the industry. In a sense it would be a super catalogue with stendardised information about every product availabla but its applications would be far wider than any system available today. The form in which the commodity file is generatad and made aveilable is opan to various interpretations. One possible eolution is dascribed in the Report. The preparation of a general commodity file is an enormous task but the manufacturers and suppliers could make a start by preparing commodity information in compatible weys. The potential of such work is that tha information could be stored in a computar deta bank for genarel eccess, or on a number of linkad computers.

5 *Proceduras*
Much of the work of the study was concerned with the development of outline procadures in which information is received, processed and put out. Procedures heve already baen developed within the industry for the preparation of bills of quantities by computers and similar initiatives are occurring in other sectors,

structurel engineering, architectural design, environmental engineering, and contracting end sub-contracting. Whila there will always be advantages for the individual who preperes procedures for specific needs the proliferation of procedures and programs is en impediment to computer application and is e waste of skilled resources. The development of suites of related procedures could meke an important contribution to the efficiency of the Industry.

6 *Codes*

Codes can make the transmission of information more reliable and more efficient. The Study Team suggest thet in the first instance a construction industry code could be limited to those procedures that are industry-wide because codes for these purposes will be more efficient end compect.

In addition to the criterie for codes already stated the Raport includes a code developed as en example to show how tha criteria for codes can be met.

7 Implementation

The fer-reaching importance of the subject required eerly consideretion of the mejor tesk of implementation. In considering the Report the Sub-Committee reoognised that the development of a framework for en information system would occupy severel years. Feilure to start immediately would lose time that could never be recovered, and greatly increase both the difficulties of acceptence end the labour of conversion from diverse aystems to a co-ordinated system.

Furthermore this would be a long end erduous task, needing central edvisory and co-ordinating machinery. Success would depend on the widespread acceptence of the Report by the industry, end it would be essentiel to secure co-operation through representative institutions over a period of several years. Eventuelly this would be likely to call for a permanent organisation, but the immediate need was to esteblish a centrel body to guide tha initial work; experience during this stage would help to define more clearly the form and neture of any permanent group that should succeed it.

The Sub-Committee therefore proposed that this initial direction could best be provided by the National Consultative Council through the egency of a representative Working Group, end thet the latter should be appointed in readiness to assume direction of the work eerly in 1969. A Support Group of professionel and executive staff within the Ministry would be needed to provide full-time assistance to the Working Group and to provide the nucleus of en advisory service to the industry on the problems of date co-ordination end coding.

This proposal hes been eccepted by the Ministry on the advice of the Main Committee. An essential preliminary to any implementetion programme will be an exhaustive sequence of discussions with all sectors of tha construction and computer industries concerned with the development of an industry-wide information system. This will involve all the representetive institutions es well es current coding interests, users generelly, research organisations, government departments and public bodies and will be cerried out through the Working Group on Data Co-ordination.

Thereafter, the necessary tesks would include the following:

Rationelise existing vocebularies, classification categories and the like, end develop such catalogues and commodlty files as may be necessery for improved information end data flow.

Co-ordinate the development of coding systems in eech sector within a common structura, end induce the convergence of existing systems.

Encourage elimination of unnaceasery veriety in methods end materials in-so-fer es these inhibit deta co-ordinetion.

Ensure thet eny dete co-ordination proposals are compatible with computer development and epplicationa.

Study new techniques for deta end information storage, hendling end retrieval and provida an information end advisory service on data co-ordinetion and coding.

These proposals envisege e continuing activity in first the introduction end thereafter the meintenanca of a co-ordineted information system throughout the industry.

The study hes not included civil engineering end whilst many of the recommendations mede for building would be relevant, future work should include civil engineering, and competibility be sought between systeme for the building and civil engineering sectors. Highways engineering would provida a promising field for initiel davelopment.

It is important that Government Departments, and the MPBW. in particular, should set an exemple to the industry by epplying the principles recommended in the Report to their own building programmes.

It is clear thet the implementation of the proposals described in this peper could bring great benefits to every sector of the industry.

Work of great velue hes already been done in the field of coding end dete co-ordination by verious sectors of the industry. A combination of centrel end sectional actlon is now needed to make the maximum use of these individuel initiatives. Development work must continue in all ereas end e focal point must be esteblished. This would provide the industry with e central source of that assistance end guidance that it will need to develop e co-ordineted information system. The convergence of existing systems must be encouraged and steps taken to ensure thet new systems fit within the agreed framework.

The work of the Sub-Committee and Study Team has given the UK construction industry e heed start in coding and data co-ordinetion on an industry-wide basis. It is in the interests of all in the industry, and the country, that this lead is meintained.

Appendix A

Committee on the Application of Computers in the Construction Industry

Chairman:	
W J Reiners BSc FSS	Director of Research and Information Ministry of Public Building and Works
Members:	
Professor G Black BSc PhD FIP DIC	Director National Computing Centre
R H Braybon MBE TD FIOB JP	T J Braybon & Sons Ltd Building Contractors
J A C Burnand BSc	Building Development Group Imperial Chemical Industries Limited
P H Dunstone TD FRICS	Monk & Dunstone Quantity Surveyors
R Geary AIOB (from October 1868)	John Laing Construction Ltd
A J Gordon OBE Dip Arch FRIBA	Alex Gordon and Partners Architects
W K Jackson FCA	Concrete Limited Specialist Sub-Contractors
S M Lovell CBE ERD TD FICE AMIMunE AMTPI FIHE	County Engineer and Surveyor County Council of the West Riding of Yorkshire
P Miller AIOB (until June 1968)	John Laing Construction Ltd
S Murray FRICS	Senior Lecturer Heriot-Watt University
B Scruby CEng FICE MIStructE MSocCE (France) FASCE MConsE	Sir Frederick Snow and Partners Consulting Engineers
Assessors	
D Bishop MICE ARICS	Director of Quantity Surveying Development Ministry of Public Building and Works
W C Brey (from October 1968)	Computer Services Division Ministry of Public Building and Works
E Danter MA AInstP	Building Research Station Ministry of Public Building and Works
H H Fairhurst MSc MIEE	Directorate General of Production Ministry of Public Building and Works
F J M Lever (until April 1968) BSc CEng FIEE F Rock-Carling (from May 1968)	Computer Division Ministry of Technology
Secretaries	
D Campbell BL Technical Secretary	Directorate General of Research and Development Ministry of Public Building and Works
J Gilbin Secretary	Directorate General of Research and Development Ministry of Public Building and Works

Appendix B

Sub-Committee on Coding and Data Co-ordination

Chairman:	
A J Gordon OBE DipArch FRIBA	Alex Gordon and Partners Architects
Members	
W T F Austin BSc CEng FICE MIStructE AMInstHE FASCE	Fraamen Fox and Partners Consulting Engineers
B K Cheala	M P Harris & Co Ltd Builders Merchants
P A Denison	Cape Universal Building Products Building Material and Componant Manufacturers
P H Dunstone TD FRICS	Monk and Dunstona Quantity Surveyors
Professor L Flatchar FRICS	Leonard Flatcher and Pertnars Quantity Surveyors
W G Howell DFC MA (Centab) AADipl (Hons) FRIBA	Howell, Killick, Pertridga and Amis Architects
W M Laing FIOB	Nathanial Grieve Builder and Joinar
P F Miller AIOB	Production Control Dapartmant John Laing Construction Co Ltd
Dr D M Parkyn BSc	National Computing Centre
I Tomlin FIBE AIOB	Howard Farrow Ltd Building Contractor
J Whittle SPDip FRIBA MTPI	Dapartmant of Architecture and Civic Design Greater London Council
Assessor	
N E Higgitt FRICS	Directorete General of Production Ministry of Public Building and Works
In Attendance	
D Campbell BL	Technical Secretary Committee on the Applicetion of Computers in the Construction Industry
W J Rainars BSc FSS	Director of Research and Informetion Ministry of Public Building and Works
Secretaries	
B C Edgill ARICS Technical Secretary	Directorate General of Research and Development Ministry of Public Building and Works
C Caudwell Secretary	Directorate General of Reseerch and Development Ministry of Public Building and Works

Appendix C

Study Team

Building Research Station Staff

Not all those listed were full time on the study; some were in the team for specific short-term studies.

*D Bishop MICE ARICS
J Britten BSc
C D Daltry
C H Farrar ARICS
B Fine BSc ARCS
Miss M K Gray
Miss C Hendford
C R Honey BArch ARIBA FNZIA
H J Hussey
D J Hutchings BA
R E Jaanes BSc
R C Marriott BA
J I 'a Nalson BA (Eng)
C Robinson
A Russell BSc
A J Sluca BSc
R F Stevens MEng AMIStructE AMICE
D Whiteside BSc
E W F Warrington BA

**With Mr Bishop's appointment as Director of Quantity Surveying Development and Chief Quantity Surveyor, MPBW as from 1st January 1968, Mr K Alsop, BSc A Inst P led the team, with Mr Bishop retaining a close interest in the work in a consultant rôle, and undertaking the drafting of the final report.*

Non-BRS Staff

C A P Crooke ARIBA	Directorate General of Research & Development Ministry of Public Building and Works
A G Foster MIHVE	Heating and Ventilating Research Association
H P Johnston MIEE	Directorate General of Research & Development Ministry of Public Building and Works
R F W Malthouse ARICS	Directorate General of Research & Development Ministry of Public Building and Works
L Monument MIStructE	Directorate General of Production Ministry of Public Building and Works
J Webster	Heating and Ventilating Research Association

Contracts for particular sections of work for the study were placed with:

ASLIB
D Brewster
Peter Burberry
CFD Partnership
Hutton and Rostron
McLennan and Partners
Robert Mathew, Johnson-Marshall and Partners
Watford Computer Centre

Appendix D

Chapter headings from the Study Team's Report

"A Study of Coding and Data Co-ordination for the Construction Industry"

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